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**UTILITY
PATENT APPLICATION
TRANSMITTAL**

Attorney Docket No. 204372000301

Total Pages 35

First Named Inventor or Application Identifier

Lynn E. Spittler and Anthony E. Maida, III

Express Mail Label No. EJ004421848US

Only for new nonprovisional applications under 37 CFR 1.53(b)

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Karyn S. Hines
Karyn S. Hines

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ☒ Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)
2. ☒ Specification [Total Pages]
(preferred arrangement set forth below)
- Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
- ☐ Drawing(s) (35 USC 113) [Total Sheets]
4. ☒ Oath or Declaration [Total Pages]
- a. ☐ Newly executed (original or copy)
 - b. ☒ Copy from a prior application (37 CFR 1.63(d)
(for continuation/divisional with Box 17 completed)
[Note Box 5 below]
 - i. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in
the prior application, see 37 CFR 1.63(d)(2) and 1.33(b)
5. ☒ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the
oath or declaration is supplied under Box 4b, is considered as being
part of the disclosure of the accompanying application and is hereby
incorporated by reference therein

6. ☐ Microfiche Computer Program (Appendix)
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
- a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ☐ Assignment Papers (cover sheet & document(s))
9. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney
(when there is an assignee)
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
12. ☒ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
14. ☐ Small Entity ☒ Statement filed in prior application,
Statement(s) Status still proper and desired
15. * ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
16. * ☐

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: 08/288,057

18. CORRESPONDENCE ADDRESS

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- ☒ If a paper is untimely filed in the above-referenced application by applicant or his/her representative, the Assistant Commissioner is hereby petitioned under 37 C.F.R. § 1.136(a) for the minimum extension of time required to make said paper timely. In the event a petition for extension of time is made under the provisions of this paragraph, the Assistant Commissioner is hereby requested to charge any fee required under 37 C.F.R. § 1.17(a)-(d) to **Deposit Account No. 03-1952**. However, the Assistant Commissioner is **NOT** authorized to charge the cost of the issue fee to the Deposit Account.

The filing fee has been calculated as follows:

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS	12 - 20 =	0	x \$18.00	\$0
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MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00	\$0
			BASIC FEE	\$760.00
			TOTAL OF ABOVE CALCULATIONS =	\$760.00
Reduction by 1/2 for filing by small entity (Note 37 C.F.R. §§ 1.9, 1.27, 1.28). If applicable, verified statement must be attached.				\$380.00
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Dated: April 28, 1999

Respectfully submitted,

By: Kate H. Murashige
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Applicant or Patentee: Spi et al.

Serial or Patent No.: 08/288,057

Attorney:

Docket No.: 0437-0003, 20

Filed or Issued: August 10, 1994

For: PROSTATIC CANCER VACCINE

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL
ENTITY STATUS 37 CFR 1.9(f) AND 1.27(c) - SMALL BUSINESS CONCERN**

I hereby declare that I am

☐ the owner of the small business concern identified below:

☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: Jenner Technologies

ADDRESS OF CONCERN: 1895 Mountain View Drive, Tiburon, California 94920

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the person employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled PROSTATIC CANCER VACCINE by inventor(s) Spitler et al.

described in

☐ the specification filed herewith

☒ the application serial no. 08/288,057, filed 10 August 1994.

☐ patent no. , issued .

If the rights held by the above identified business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or by a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME:

ADDRESS:

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification or any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. [37 CFR 1.28(b)]

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING:

TITLE OF PERSON OTHER THAN OWNER:

ADDRESS OF PERSON SIGNING:

SIGNATURE Spitler et al.

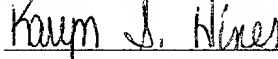
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Karyn S. Hines

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of Lynn E. SPITLER *et al.*

Examiner: Unassigned

Serial No.: Continuation of 08/288,057

Group Art Unit: Unassigned

Filing Date: Even date herewith

For: PROSTATIC CANCER VACCINE

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination, please amend the specification as follows:

On page 1, under the title, please delete the paragraph on lines 2-5 and substitute the following

--This application is a continuation of U.S. Serial No. 08/288,057 filed 10 August 1994, now allowed, which is a continuation-in-part of U.S. Serial No. 08/105,444 filed 11 August 1993 and now pending. The contents of these applications are incorporated herein by reference.--

Please amend the claims as follows:

Please delete claims 1-12 and substitute the following claims:

--13. A method to elicit an antitumor immune response to prostate tumors in a subject, which method comprises

administering to said subject at least one active ingredient formulated for administration to said subject,

wherein said active ingredient comprises or expresses at least one antigen over-represented in the prostate gland or an immunologically effective portion thereof,

wherein said active ingredient is an immunologically reactive portion of human prostate-specific antigen (PSA); or

human prostate-specific membrane antigen (PSMA) or an immunologically effective portion thereof; or

prostatic acid phosphatase (PAP) or an immunologically reactive portion thereof; or mixtures of the foregoing; or

is a nucleic acid that generates said antigen or antigens *in situ*.

14. The method of claim 13 wherein said active ingredient is a protein which is said portion of human PSA.

15. The method of claim 13 wherein said active ingredient is human PSMA or said portion thereof.

16. The method of claim 13 wherein said active ingredient is PAP or said portion thereof.

17. The method of claim 13 wherein said active ingredient is a nucleic acid which generates said portion of human PSA *in situ*.

18. The method of claim 13 wherein said active ingredient is a nucleic acid that generates PSMA or said portion thereof *in situ*.

19. The method of claim 13 wherein said active ingredient is a nucleic acid that generates said PAP or said portion thereof *in situ*.

20. The method of claim 13 wherein the active ingredient is encapsulated in liposomes and/or coupled to liposomes.

21. The method of claim 20 wherein said liposomes contain an adjuvant.

22. The method of claim 13 which further includes at least one adjuvant that enhances the antitumor immune response.

23. The method of claim 22 wherein said adjuvant is selected from the group consisting of Freund's complete adjuvant; alum; lipid A; monophosphoryl lipid A; *Bacillus Calmette-Guerin* (BCG) or other bacteria polysaccharides; saponins; detoxified endotoxin (DETOX); muramyl tripeptide or muramyl dipeptide or their derivatives; SAF1; lymphokines; cytokines; colony stimulating factors; nonionic block copolymers; and immune stimulating complexes (ISCOMS).

24. The method of claim 13 wherein said subject is afflicted with metastatic prostate cancer; and/or wherein said subject has been surgically treated to excise said tumor but is at risk for recurrence.--

REMARKS

The claims have been amended to read on embodiments deleted from the claims in the parent application herein in order to expedite prosecution. No new matter has been added and entry of the amendment is respectfully requested.

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, applicants petition for any required relief including extensions of time and authorize the Assistant Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing docket no. 204372000301. However,

the Assistant Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Respectfully submitted,

Dated: April 28, 1999

By: Kate H. Murashige
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P A T E N T
Atty Dkt: 0437-0003.20

- 1 -

Printed Name of Person Mailing Paper or Fee PROSTATIC CANCER VACCINE

Signature of Person Mailing Paper or Fee

This is a Continuation-In-Part of United States
Serial Number 08/105,444 filed 11 August 1993 now pending.
The contents of this application are incorporated herein
5 by reference.

Technical Field

The present invention is related to the field of
the prevention and treatment of prostate cancer. More
specifically, the invention concerns the use of
10 (1) prostate associated antigen(s), (2) expression systems
for prostate associated antigen(s) which are peptides or
proteins or (3) antiidiotypic antibodies bearing the
internal image of the antigen(s) formulated as vaccines to
produce an immune response to prevent or treat prostate
15 cancer.

Background Art

Cancer is the second leading cause of death in
the United States accounting for almost 500,000 deaths
each year. More than 1,000,000 new cases of cancer are
20 diagnosed in the United States annually. The incidence of
cancer is increasing largely as a byproduct of the greater
lifespan of the aging population. Cancer is a leading
cause of death in all industrialized nations, where life
expectancy continues to increase. It is expected that
25 cancer morbidity and mortality will continue to increase
in all industrialized areas of the world.

Prostate cancer is the most common malignancy
among males in the U.S. accounting for 28% of all

malignancies in men. It is estimated there will be 165,000 new cases of prostate cancer in the United States in 1993 and 35,000 deaths (Boring, CC, et al CA Cancer J Clin (1993) 43:7-26).

5 Prostate cancer continues to be refractory to treatment despite many years of efforts to improve therapy. Surgery and radiation remain the mainstays of therapy; improved therapeutic modalities are needed. Vaccine development has been slow and no vaccine approved
10 by the FDA for marketing currently exists for any form of cancer. There is therefore a continuing need for the development of new therapeutic and prophylactic compounds effective in the prevention and treatment of prostate cancer

15 The use of vaccines as cancer therapy is known (reviewed in Hoover, Jr. HC and Hanna, Jr. MG, Biological Therapy of Cancer (1991) Devita, Jr., DT, et al., eds. J.B. Lippincott Co., pp 670-701. There are many reports in the open literature of vaccines consisting of whole
20 autologous or allogeneic tumor cells or their extracts formulated with bacterial adjuvants such as Bacillus-Calmette-Guerrin (BCG), *Corynebacterium parvum* or vaccinia virus. There has been no report of the use of an antigen unique to the prostate such as a prostate associated
25 protein or an antiidiotypic antibody bearing the internal image of the prostate antigen as a vaccine for prostate cancer.

U.S. Patent No. 3,960,827 describes a cancer-associated polypeptide antigen which is described as
30 having a molecular weight of 20-27 kd and as associated with a number of types of cancers. The use of this

antigen in antitumor vaccines is suggested. U.S. Patent No. 4,372,945 discloses the use of tumor cells as secondary antigens in immunotherapeutic treatment of cancer. U.S. Patent No. 4,446,122 discloses the use of
5 prostate specific antigen (PSA) isolated from human tissue to prepare antibodies for tumor diagnosis. U.S. Patent No. 4,468,457 describes the isolation of a colon specific antigen which is digested with trypsin to obtain a peptide used to produce monospecific antibodies against the
10 antigen. U.S. Patent No. 4,689,222 describes a method for alleviation of symptomatic pain associated with neoplasia by administering a low dose of human chorionic gonadotropin insufficient to provoke a humoral response. U.S. Patent No. 4,877,611 describes vaccines containing
15 tumor-associated antigens. The vaccines contain the tumor-associated antigen in the presence of specific adjuvants. PCT application WO91/11465 describes anticancer vaccines using antiidiotypic antibodies that mimic an antigen produced by or associated with the
20 malignant cell.

U.S. Patent No. 5,053,224 issued October 1, 1991 describes the preparation of both polyclonal and monoclonal antiidiotypic antibodies that recognize the paratope of an antitumor antibody. The issued patent
25 further describes the use of these antiidiotypic antibodies generally to stimulate the production of anti antiidiotypic antibodies in tumor patients. Copending patent application No. 07/938,079 filed 8/31/92, the disclosure of which is incorporated herein by reference
30 discloses the use of antiidiotypic antibodies generally to stimulate an antitumor T cell response for prevention

and/or therapy of cancer. Copending patent application
No. 07/800,474 filed 11/26/91, the disclosure of which is
incorporated herein by reference describes generally the
use of pure tumor antigen encapsulated in or conjugated to
5 liposomes for the treatment and prevention of cancer.

The present invention concerns the use of
prostate antigens or their representatives in vaccines to
produce an immune response to prevent or treat prostate
cancer.

10 Disclosure of the Invention

While the prior art suggests the use of antigens
uniquely associated with tumor tissue as components of
antitumor vaccines, there appears to be no suggestion to
use antigens which are uniquely represented on host tissue
15 for the tumor. Since the prostate is not an essential
organ, elimination of the prostate gland, which may be a
concomitant effect of the vaccines of the invention, does
not adversely impact the general health of the subject.
Thus, prostate cancer offers a unique opportunity for
20 treatment with vaccines which characterize the host organ
itself, rather than the malignant or metastatic nature of
the cells per se.

Accordingly, in one aspect, the invention is
directed to a method to induce an antitumor immune
25 response in a potential or actual prostate tumor-bearing
subject which method comprises administering to said
subject a composition comprising an active ingredient
selected from the group consisting of at least one antigen
over-represented in the prostate gland or an
30 immunologically effective portion thereof; an expression

system capable of generating *in situ* said antigen; and an antiidiotypic antibody or fragment thereof which mimics said antigen.

In another aspect, the invention is directed to
5 a pharmaceutical or veterinary vaccine for eliciting an antitumor immune response to prostate tumors which comprises, as active ingredient, at least one antigen over-represented on the prostate gland with respect to other tissues or an immunologically effective portion
10 thereof; or an expression system capable of generating *in situ* said antigen; or an antiidiotypic antibody or fragment thereof which mimics said antigen.

Modes of Carrying out the Invention

The invention utilizes compositions which
15 contain, as active ingredient, at least one antigen which is over-represented on prostate tissue or an immunologically effective portion thereof or a representative thereof. By "over-represented" is meant that the concentration of this antigen in prostate is
20 sufficiently higher than its concentration in any other tissue such that the prostate can effectively be targeted by the immune response raised against this antigen with relative sparing of other organs or tissues. Sparing can be measured by overall clinical toxicity to the subject.
25 Toxicity to the subject is generally grade 3 or less, preferably grade 2 or less most preferably grade 1 or grade 0. The approach does not lose value with regard to metastatic prostate cancer, since the antigens over-represented in the prostate gland are also carried by the
30 metastatic cells.

By an "immunologically effective portion thereof" is meant that portion of an antigen, taken alone, which is capable of eliciting an immune response. Typically, such portions represent an individual epitope
5 or a specific subset of the epitopes that comprise the complete antigen.

The antigen can be any substance which is, in the sense used above, unique to or over-represented in prostate tissue. Thus, the antigen may be a protein or a
10 peptide, or peptide fragment of the protein, or may be a carbohydrate, glycoprotein, lipoprotein or lipid. Most commonly, the antigen will be a protein or a peptide fragment thereof; or a protein which includes the amino acid sequence of the antigen or epitope. Proteins may be
15 modified by glycosylation or other derivatization. It is clear that in the case of protein antigen, peptides representing epitopes of the antigen may also be used. The relevant amino acid sequence can be supplied in the context of a larger fusion protein that contains amino
20 acid sequence heterologous to the antigen or its epitope.

It is also understood that in the case of peptide or protein antigens, the antigens may be generated *in situ* by providing suitable expression systems containing the DNA encoding the desired peptide or protein
25 (including fusion proteins containing the relevant sequence); the expression systems can then be used as the active ingredient in the vaccines. By "expression system" is meant any DNA construct which is effective in producing the encoded protein in the desired environment.
30 Conventional expression systems contain the encoding DNA operably linked to control sequences such as promoters,

terminating signals and the like. However, it has recently been shown that the coding sequences per se can behave as effective expression systems *in situ* when injected into animals. The work of Ulmer, J.B., et al.,
5 Science (1993) 259:1745-1749, and summarized in a "Research News" presentation by Cohen, J., in the same issue on pages 1691-1692 demonstrates this concept. Injection of "naked" DNA encoding the nucleoprotein of influenza A was shown to be protective against a challenge
10 of the virus. Although it is not understood why such naked DNA is apparently capable of expression to provide the protein *in situ*, this apparently is the case. Accordingly, such "naked" DNA is included in the definition of expression systems herein.

15 Furthermore, any antigen may be mimicked by an antiidiotypic antibody; it has long been recognized that antiidiotypic antibodies can be prepared that bear an internal image of tumor associated antigens, (Herlyn, D., et al. Science (1986) 232:100-102.

20 Illustrative Antigens

The first widely studied antigen which is over-represented in the prostate gland is prostatic acid phosphatase (PAP). Elevated levels of PAP in the bloodstream are considered indicative of prostate cancer,
25 and this enzyme has been widely studied (Yam, Amer J Med (1974) 56:604. Improved methods of cancer detection using this enzyme were described by Chu et al. in PCT application WO79/00475. The structure of the enzyme has also been studied by Sharief, F.S., et al., Biochem
30 Biophys Res Commun (1992) 184:1468-1476 and by Van Etten,

R.L., et al., J Biol Chem (1991) 266:9993-9999. The nucleotide sequence encoding human PAP has been determined from a full length cDNA clone (Sharief, F.S., et al., Biochem Biophys Res Commun (1989) 180:79-86; Tailor, P.G., et al., Nucleic Acids Res (1990) 18:4928.

In addition to PAP, other suitable candidates for antigens over-represented on prostate tissue are known. Most prominent among these is "prostate specific antigen" or "PSA".

U.S. Patent No. 4,446,122 discloses methods for the purification of human prostate specific antigen (PSA) from either normal or cancerous human prostate tissue, prostatic fluid, cultured human prostatic malignant cells, or their media. Also disclosed are polyclonal and monoclonal antibodies to the prostate specific antigen and their use in a method for diagnosing carcinoma of the prostate. PSA is a member of the glandular kallikrein family and is a protease with a restricted chymotrypsin-like specificity; it is present in the epithelial cells comprising the prostatic ductal elements. It has been demonstrated in all primary and metastatic prostatic tumors tested and in normal benign prostate but not in nonprostatic cancer tissues or in normal tissues other than prostate.

The complete amino acid sequence of PSA from human seminal plasma has been determined (Watt KW et al., Proc Natl Acad Sci USA (1986) 83:3166-3170). PSA consists of a single polypeptide chain with 240 amino acid residues and has a calculated molecular weight of 26,496. Carbohydrate side chains are possibly attached. The cDNA encoding PSA has been produced and characterized (Lundwall

668240-8260060
A, Lilja, H, FEBS Lett (1987) 214:317-322; Schultz P, et
al., Nucleic Acids Res (1988) 16:6226; and Henttu P and
Bihko P, Biochem and Biophys Res Commun (1989) 160:903-
910). The gene for the PSA has also been characterized
5 (Lundwall A, Biochem and Biophys Res Commun (1989)
162:1151-1159, Riegman, PHJ, et al., Biochem and Biophys
Res Commun (1989) 159:103-111 and Klobeck G, et al.,
Nucleic Acids Res 1989 17:3981.)

cdNA encoding a different prostate specific
10 membrane antigen (PSMA) has also described (Israeli RS et
al., Cancer Res (1993) 53:227-230). The cDNA consists of
2.65 kilobase and a portion of the coding region from
nucleotide 1250 to 1700 has 54% homology to the human
transferrin receptor mRNA. In contrast to PSA and
15 prostatic acid phosphatase which are secreted proteins,
the prostate specific membrane antigen is an integral
membrane protein.

The PSMA (molecular weight 100,000) similarly
has representation on both benign and neoplastic prostate
20 cells with more intense staining seen with malignant
cells. Metastases of prostate cancer also have
representation of the antigen. This antigen, therefore,
is an appealing as a vaccine candidate for the same
reasons as those described for PSA. Moreover, PSMA is an
25 integral membrane protein rather a secreted protein as is
PSA ,and, therefore, may be an even more appropriate
vaccine component.

The foregoing list of known antigens which are
over-represented on prostate: prostatic acid phosphatase
30 (PAP); prostate specific antigen (PSA); and prostate
specific membrane antigen (PSMA) is offered for the

purpose of illustration. These well known antigens (or the epitope bearing fragments thereof) are proteins (or peptides) and are useful in the vaccines of the invention. However, the invention includes any other antigens
5 substantially uniquely present on the prostate gland so that prostate derived tissue can be distinguished from other tissue by virtue of the presence of these antigens.

Preparation of the Antigens

Antigens useful in the vaccines may be prepared
10 by any suitable methods. The antigens may be isolated and purified from prostatic tissue using conventional methods. The purification of the representative antigens set forth above is already known, and art-known techniques for their purification may be employed. In addition, affinity
15 columns employing antibodies or fragments thereof for specific adsorption of the desired antigen can be used to advantage. The nature of the purification method will, of course, depend on the nature of the antigen obtained.

For antigens that are proteins or peptides, a
20 number of options is available in addition to isolation and purification. In addition to genetic engineering techniques, peptides, and even proteins, can be prepared using standard chemical synthesis methods, preferably the commercially available solid-phase-based techniques.
25 These techniques are well known and automated systems to conduct them can be purchased and employed according to the manufacturer's instructions.

In addition, protein or peptide antigens may be prepared using genetic engineering. Procedures for the
30 production of pure antigens from the DNA encoding the

desired antigen are well known to those skilled in the art. Briefly, the preferred DNA is expressed in a suitable recombinant expression vector such as those adapted for *E. coli*; yeast, such as *Saccharomyces*
5 *cerevisiae* or *Pichia pastoris*; or filamentous fungi such as *Aspergillus nidulans*. The yeast, fungi or bacteria, can be grown in continuous culture producing recombinant protein which may be then be isolated and purified. Alternately, higher organisms may be used for recombinant
10 protein production. For example, the encoding DNA may be expressed in an insect virus expression vector such as recombinant baculovirus and the resulting recombinant baculovirus then used to infect susceptible cultured SF9 cells (*Spodoptera frugiperda* insect cells) to produce the
15 protein product of the DNA. Other expression systems commonly used include those appropriate for production of proteins in mammalian cells, such as CHO cells or even plant cells. The choice of host will determine the nature of the posttranslational processing, and is a
20 consideration in devising purification techniques.

The preparation of recombinant forms of protein antigens in a variety of host cells results in a variety of posttranslational modifications which affect the immunogenicity and other pharmaceutical properties, such
25 as pharmacokinetics, of the product. Accordingly, although human prostate-specific antigen (PSA) isolated from human tissues has been used to induce the production of antibodies for diagnostic use, the immunogen prepared in this way differs from the immunogen as prepared in
30 nonhuman cells, such as insect cells. The posttranslational modifications peculiar to the

recombinant host result in alternations in glycosylation pattern, folding, and the like.

The technique of recombinant expression may also be used to produce portions of the desired antigen rather than the entire antigen. For example, it maybe desirable to express the extracellular domain without the intracellular and/or transmembrane domains to facilitate purification of membrane associated antigen. Similarly, it may be desirable to express just the epitopes of choice eliminating unrelated or competing epitopes. All of these may be accomplished through techniques well known to those skilled in the art. Techniques for identifying peptides representing important epitopes of the antigen are well known, and are summarized in Berzofsky, JA and Berkower IJ, Fundamental Immunology 2nd edition, Raven Press, (1989) W. E. Paul (ed.) pp. 169-208. The peptides identified may then be synthesized using conventional solid phase peptide synthesis (Merrifield RB, J Am Chem Soc (1983) 85:2149-2154) which has now been automated (Merrifield RB, Science (1965) 150:178-185) as described above. An alternate method designed to make large numbers of peptides for screening is the "tea-bag" technique (Houghten RA, Proc Natl Acad Sci USA (1985) 82:5131-5135.

Whether the antigen or a suitable epitope is prepared synthetically or recombinantly, it may be prepared initially as a fusion protein containing amino acid sequence heterologous to the amino acid sequence of interest. Construction of such fusion proteins is common in recombinant production in order to stabilize the product produced in the cell. It may be unnecessary to stabilize the desired peptide or protein in this way,

especially if it is to be secreted from the recombinant cell. However, the fusion protein itself may be useful as an ingredient in the vaccine, especially if the additional heterologous amino acid sequence supplies an

5 immunogenicity enhancing property on the relevant epitope. Thus, the fusion proteins which contain the relevant amino acid sequences may be used simply as precursors of the immunogen or may provide the end-product for use in the vaccine. If the fusion protein is intended as an
10 intermediate, it is useful to provide a cleavage site between the heterologous portion and the desired epitope. Such cleavage sites include, for example, the target sequences for various proteolytic enzymes, or, if the epitope does not contain methionine, may constitute simply
15 a methionine residue which is cleaved by cyanogen bromide. Methods to provide suitable cleavage sites are well known in the art.

Preparation of Antiidiotypic Antibodies

An alternative approach in formulating the
20 vaccines of the invention is to prepare a "representative" of the antigen in the form of an antiidiotypic antibody which bears an internal image of the antigen.

Antiidiotypic antibodies can be prepared with respect to antigens of any chemical nature, including, in addition to
25 peptides and proteins, carbohydrates, lipids, and small molecules.

Ways to prepare both monoclonal and polyclonal antiidiotypic antibodies which bear the internal image of the tumor associated antigens is described in detail in
30 U.S. Patent No. 5,053,224 the disclosure of which is

incorporated herein by reference. Briefly, polyclonal antiidiotypic antibodies may be produced by immunizing animals with monoclonal idiotypic antibodies raised against the antigen and screened for reactivity with the antigen and screening for antisera which react with
5 idiotypic antibodies to the prostate antigens. Monoclonal antibodies may also be prepared from such animals using standard techniques of immortalizing the antibody secreting cells of the animal and screening the cultures
10 with idiotypic antibodies in competition with the prostate antigen. Human or murine monoclonals are preferred; polyclonal preparations made in a variety of mammalian systems may also be used.

Vaccine Compositions

15 While the prostate antigens of the invention may by themselves constitute the vaccine, it is a further feature of the invention these prostate antigens are administered in a formulation designed to enhance the antitumor response. Formulations include but are not
20 limited to incorporation of the prostate antigen into a liposome with or without out additional adjuvants, use of adjuvants and/or cloning DNA encoding of peptide or protein antigens into a viral or bacterial vector.

Of course, the formulations may not contain only
25 a single active ingredient; any combination of the immunogenic substances of the invention can be used. However, generally, such "cocktails" comprise active ingredients of the same type -- i.e., generally the active ingredient mixture will include either two or several
30 antigens, two or several expression systems for protein or

peptide antigens, or two or several antiidiotypic
antibodies representing different antigens. However,
there is no theoretical reason that, for example, a single
vaccine could not include both antiidiotypic antibody and
5 an expression system.

If the protein form of the antigen is to be
used, it may be desirable to couple the protein or peptide
to a carrier in order to enhance immunogenicity. Such
coupling can be effected using standard and conventional
10 coupling techniques, optionally utilizing spacer moieties
in order to provide correct juxtaposition of the carrier
and epitope. A large number of suitable carriers for such
purposes is known, including keyhole limpet hemocyanin,
rotavirus VP6 inner capsid protein, pilin protein and the
15 like. In addition, enhanced immunogenicity may be
obtained by supplying the epitope or antigen in the form
of a fusion protein wherein the epitope bearing portion is
fused to heterologous amino acid sequences to enhance the
effect of the epitope administered.

Whether administered alone, coupled to carrier,
or as part of a fusion protein, the epitope bearing
proteins of the invention, the DNA constructs and the
antiidiotypic antibodies are administered in the presence
of suitable excipients. Conventional excipients may be
25 used, but the following are of particular interest.

Compositions employing liposomes encapsulating
or conjugating to the active ingredient of the vaccine may
be used and are especially preferred. Liposomes localize
in the reticuloendothelial system, one of the sites of
30 generation of the immune response in a mammalian host
including humans and enhance the immune response to

antigens incorporated in the liposome The liposomal
formulations incorporating the prostate antigens may also
include immune system adjuvants, including one or more of
lipopolysaccharide (LPS), lipid A, or muramyl dipeptide
5 (MDP) as described in Liposomes, Ostro MJ, Editor, Marcel
Dekker, Inc. (1983) page 249). Other immune system
adjuvants such as glucan or certain cytokines, including
interleukins, interferons, and colony stimulating factors,
such as IL1, IL2, gamma interferon, and GM-CSF may also be
10 incorporated with antigen into the liposome.

The prostate antigen may also be formulated with
various adjuvants which enhance antitumor response, in
particular, cellular immune response to the prostate
antigens. Such adjuvants include, but are not limited to,
15 Freund's Complete Adjuvant, alum, lipid A, monophosphoryl
lipid A, *Bacillus-Calmette-Guerrin* (BCG) and other
bacteria, polysaccharides such as glucan, acemannan, and
lentinan, saponins, detoxified endotoxin (DETOX), muramyl
tripeptide, muramyl dipeptide and their derivatives, SAF1,
20 lymphokines and cytokines, including interleukins and
interferons such as IL2 and gamma interferon, as well as
colony stimulating factors such as GM-CSF, nonionic block
copolymers, or immune stimulating complexes (ISCOMS).

In an additional formulation the DNA encoding
25 proteins such as PAP, PSA, PSMA, or portions of these is
administered in a viral expression vector such as vaccinia
or other pox virus or bacterial vectors such as BCG.
Viral vectors are described, for example, by Hruby, D E,
Vet Parasitol (1988) 29:281-282, and by Uiu, SI "AIDS
30 Research Reviews" Dekker, Inc. (1991) 1:403-416. The
recombinant vectors may be administered in the traditional

manner via a skin scratch or an injection or may included in a liposome injectable as described above. As noted above, "naked" DNA can also be used as a form of expression system in the vaccines of the invention.

5 Administration and Use

In the method of the invention, the prostatic cancer vaccine is administered for both prevention and treatment of prostatic cancer. The prostatic cancer vaccine of the invention is administered to subjects at
10 risk for the development for the development of prostate cancer or showing a diagnosis thereof. While the target cancer is specifically that associated with the prostate gland, the effect of the vaccines of the invention will be to enhance the potential of the immune system generally,
15 generating T cell responses as well as the production of antibodies. To the extent that the enhancement of the cellular immune system is effected, the vaccines of the invention are useful in the prevention and therapy of other types of cancer as well as that of the prostate.
20 Thus, the cellular responses generated are effective against, for example, cancers of the colon, lung, bladder, stomach, breast, cervix, and the like as well as certain lymphomas and leukemias.

The compositions are formulated for parenteral
25 administration using a formulation appropriate to the administration route such as those described in Remington's Pharmaceutical Sciences, latest edition, Mack Publishing Company, Easton, PA.

Suitable routes for parenteral administration
30 include intracutaneous, subcutaneous, intramuscular, and

intravenous injection or oral administration. For
formulation for injection, the vaccine is generally
formulated in a suitable liquid such as Hank's solution or
Ringer's solution along with suitable excipients providing
5 buffering, stabilizing, and other desirable
characteristics, as well as additional components desired,
as described below. Alternative routes for parenteral
administration include oral administration in which case
additional components for stabilizing the preparation may
10 also be included.

In addition to administration in an appropriate
isotonic vehicle for injection, liposomes are desirably
used as a carrier to direct the product to the immune
system as disclosed in copending application 07/800,474,
15 the disclosure of which is incorporated herein by
reference.

In general, the dosage range for the prostate
antigens of the invention is of the order of 0.01 μ g-100
mg per dose, preferably 0.1 μ g-10 mg per dose and more
20 preferably 10 μ g-1 mg per dose. Suitable volumes for
parenteral administration are about 0.1-5 ml.

The protocols may involve administration of
cocktails of various antigens or their representatives or
may involve sequential administration of these active
25 ingredients. The antigens and their representatives may
represent a variety of immunogens or may represent
different forms of the same immunogen. In general,
protocols involving one or more immunogenic species can be
designed according to routine optimization procedures.

30 The prostatic cancer vaccine of the invention is
administered generally in multiple doses, typically once

per week for one or two months and with decreasing frequency thereafter for a period extending to about one year. Following the initial one year course of vaccination, booster inoculations may be given every two
5 months to five years. Alternate protocols may be appropriate in individual instances. For example, if vaccine formulation involves the use of liposomes and is administered intramuscularly, the vaccine might be administered once a month from the inception because of
10 the depot effect of the liposomes.

In addition, it may be advantageous to substitute for the first administrations a recombinant form of the antigen wherein the antigen gene or cDNA is administered in a living expression vector such as
15 vaccinia virus.

It is a further feature of the invention that the vaccine may be formulated along with adjuvants which enhance the immune responses as described above. The prostate antigens may be formulated with these adjuvants
20 alone or they may be incorporated into liposomes.

Claims

1. A pharmaceutical or veterinary vaccine for
eliciting an antitumor immune response to prostate tumors
in a subject which comprises an active ingredient selected
5 from the group consisting of

at least one antigen over-represented in the
prostate gland or an immunologically effective portion
thereof with the proviso that said antigen is other than
human prostate specific antigen (PSA) produced in human
10 cells;

an expression system capable of generating *in*
situ an antigen over-represented on the prostate gland
with respect to other tissues or an immunologically
effective portion thereof;

15 naked DNA encoding said antigen or portion; and
an antiidiotypic antibody or fragment thereof
which mimics said antigen.

2. The vaccine of claim 1 wherein said antigen
is selected from the group consisting of PSA, PSMA and
20 PAP.

3. The vaccine of claim 1 wherein said antigen
is a protein which comprises an amino acid sequence over-
represented in the prostate gland or an immunologically
effective portion thereof and heterologous amino acid
25 sequence.

4. The vaccine of claim 1 wherein the antigen
is encapsulated in a liposome or coupled to a liposome and

- wherein said liposomes optionally contain an adjuvant or are precipitated with alum.

5 5. The vaccine of claim 1 which further includes at least one adjuvant capable of enhancing said antitumor immune response.

6. The vaccine of claim 5 wherein said adjuvant is selected from the group consisting of Freund's complete adjuvant; alum; lipid A; monophosphoryl lipid A; *Bacillus Calmette-Guerin* (BCG) or other bacteria
10 polysaccharides; saponins; detoxified endotoxin (DETOX); muramyl tripeptide or muramyl dipeptide or their derivatives; SAF1; lymphokines; cytokines; colony stimulating factors; nonionic block copolymers; and immune stimulating complexes (ISCOMS).

15 7. The vaccine of claim 1 wherein said active ingredient consists essentially of DNA comprising a nucleotide sequence encoding said antigen or portion thereof.

20 8. The vaccine of claim 1 wherein said active ingredient consists essentially of a living expression vector for said antigen or portion thereof.

9. The vaccine of claim 1 which comprises as active ingredient
at least one antigen over-represented on the
25 prostate gland with respect to other tissues or an immunologically effective portion thereof with the proviso

that said antigen is other than human prostate specific antigen (PSA) produced in human cells.

10. The vaccine of claim 9 which comprises as active ingredient

5 at least one antigen wherein said antigen is a protein which comprises an amino acid sequence over-represented on the prostate gland with respect to other tissues or an immunologically effective portion thereof and heterologous amino acid sequence.

10 11. A method to induce an antitumor immune response in a potential or actual prostate tumor-bearing subject which method comprises administering to said subject the vaccine of claim 1.

15 12. The method of claim 11 wherein said subject is afflicted with metastatic prostate cancer; and/or wherein said subject has been surgically treated to excise said tumor but is at risk for recurrence and wherein said subject is optionally in a "neoadjuvant" setting prior to surgical excision of said prostate tumor; or

20 wherein said subject is a potential prostate tumor-bearing subject at risk for said tumor.

Abstract

Vaccines capable of eliciting an immune antitumor response for prostate tumors are disclosed. The active ingredient in such vaccines is selected from the

5 group consisting of

at least one antigen over-represented in the prostate gland or an immunologically effective portion thereof;

an expression system capable of generating *in*

10 *situ* said antigen or portion;

a naked DNA encoding said antigen or portion;

and

an antiidiotypic antibody or fragment thereof which mimics said antigen or portion.

COMBINED DECLARATION AND POWER OF ATTORNEY
FOR CONTINUATION-IN-PART APPLICATION

AS A BELOW-NAMED INVENTOR, I HEREBY DECLARE THAT:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if more than one name is listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: **PROSTATIC CANCER VACCINE**, the specification of which

(check one) ☐ is attached hereto
☒ was filed on 10 August 1994

as application serial no. 08/288,057.

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE.

I acknowledge and understand that I am an individual who has a duty to disclose information which is material to the patentability of the claims of this application in accordance with Title 37, Code of Federal Regulations, §§ 1.56(a) and (b) which state:

"(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be

material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

- (1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or
- (2) It refutes, or is inconsistent with, a position the applicant takes in:
 - (i) Opposing an argument of unpatentability relied on by the Office, or
 - (ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability."

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below, and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) and (b) set forth above which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.: 08/105,444
Filing Date: 11 August 1993
Status (patented, pending, abandoned): Pending

As to the subject matter of this application which is common to said earlier application, I do not know and do not believe that the same was ever known or used in the United States of America before my or our invention thereof or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said earlier application, or in public use or on sale in the United States of America more than one year prior to said earlier application. Said common subject matter has not been patented or made the subject of an inventor's certificate issued before the date of said earlier application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to said earlier application; and the earliest application(s) for patent or inventor's certificate on said invention filed by me or my legal representatives or assigns in any country foreign to the United States of America is identified below, as well as all other such applications (if any) filed more than twelve months prior to the filing date of this application:

The priority of the earliest application(s) (if any) filed within a year prior to said pending prior application is hereby claimed under 35 U.S.C. § 119.

As to the subject matter of this application which is not common to said earlier application, I do not know and do not believe that the same was ever known or used in the United States of America before my or our invention thereof or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to the date of this application, or in public use or on sale in the United States of America more than one year prior to the date of this application. Said subject matter has not been patented or made the subject of an inventor's certificate issued in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to the date of this application; and the earliest application(s) for patent or inventor's certificate on said subject matter filed by me or my legal representatives or assigns in any country foreign to the United States of America is identified below, as well as all other such applications (if any) filed more than twelve months prior to the filing date of this application:

The priority of the earliest application(s) (if any) filed within a year to this application is hereby claimed under 35 U.S.C. § 119.

I hereby appoint the following attorneys and agents to prosecute that application and to transact all business in the Patent and Trademark Office connected therewith and to file, to prosecute and to transact all business in connection with all patent applications directed to the invention:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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663240-84600E6D